NFC (Near Field Communications)

FCC/IC Test Report

FOR:

Square, Inc.

Model Name: S8

Product Description: Wireless card reader accepting NFC contactless payments and EMV chip card transactions.

47 CFR Part 15 Subpart C Section 15.225
RSS-210 Issue 9, Annex B.6, RSS-Gen Issue 4

TEST REPORT #: EMC_SQUAR-023-16001_15.225_NFC_rev2

DATE: 2017-01-03

FCC listed
A2LA
Accredited

IC recognized #
3462B-1

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1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.225 of Title 47 of the Code of Federal Regulations and Industry Canada Standards RSS-210 Issue 9, Annex B.6 and no deviations were ascertained during the course of the tests performed.

Company	Description	Model #
Square, Inc.	Wireless card reader accepting NFC contactless payments and EMV chip card transactions.	S8

This report is reviewed by:

Date	Section	Name	Signature
2017-01-03	Compliance	James Donnellan (Sr. EMC Test Engineer)	James Donnellan Digitally signed by James Donnellan DN: cn=James Donnellan, c=US, o=Cetecom Inc., ou=Compliance, email=james.donnellan@cetecom.com Date: 2017.01.03 12:26:31 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
2017-01-03	Compliance	Douglas Antioco (EMC Test Engineer)	Douglas Antioco 2017.01.03 12:08:21 -08'00'

The test results of this test report relate exclusively to the test item specified in Section3.
CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of the CETECOM Inc USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	411 Dixon Landing Road Milpitas, CA 95035 U.S.A.
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Test Engineer	Douglas Antioco
Project Manager	Laith Saman

2.2 Identification of the Client

Applicant's Name:	Square, Inc.
Street Address:	1455 Market Street, Suite 600
City/Zip Code	San Francisco, CA 94103
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	Dongguan Fuqiang Electronics Co.,Ltd
Manufacturers Address:	Chenguei Industry District
City/Zip Code:	Dong-Keng, Dong-Guan, Guang-Dong 523457
Country:	China

2.4 **Environmental conditions during Test:**

The following environmental conditions were maintained during the course of testing:
Ambient Temperature: 20 - 25°C
Relative humidity: 40-60%

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name / Model No:	S8
Product Description:	Wireless card reader accepting NFC contactless payments and EMV chip card transactions.
Product Type:	NFC (Near Field Communication)
FCC-ID :	2AF3K-SHR1
IC-ID:	21827-JBR1
HVIN:	S8
PMN:	Square Reader
Operating Frequency:	13.56 MHz
Type(s) of Modulation:	ASK (Amplitude Shift Keying)
Number of channels:	1
Antenna Info:	Magnetic Loop antenna
Rated Operating Voltage Range (DC):	Li-ion Battery 3.2V (Low) / 3.7V (Nominal) / 5.0 V (Max)
Operating Temperature Range:	0 ºC to 40 ºC
Test Sample status:	Production
Other Radios included in the device:	1. BT LE (2.4 GHz band of operation)

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	632LS08403000298	A-PRD-0084	Ver.201043	Radiated Emissions Measurements
2	632LS09201001763	A-PRD-0084	Ver.201043	Conducted Measurements

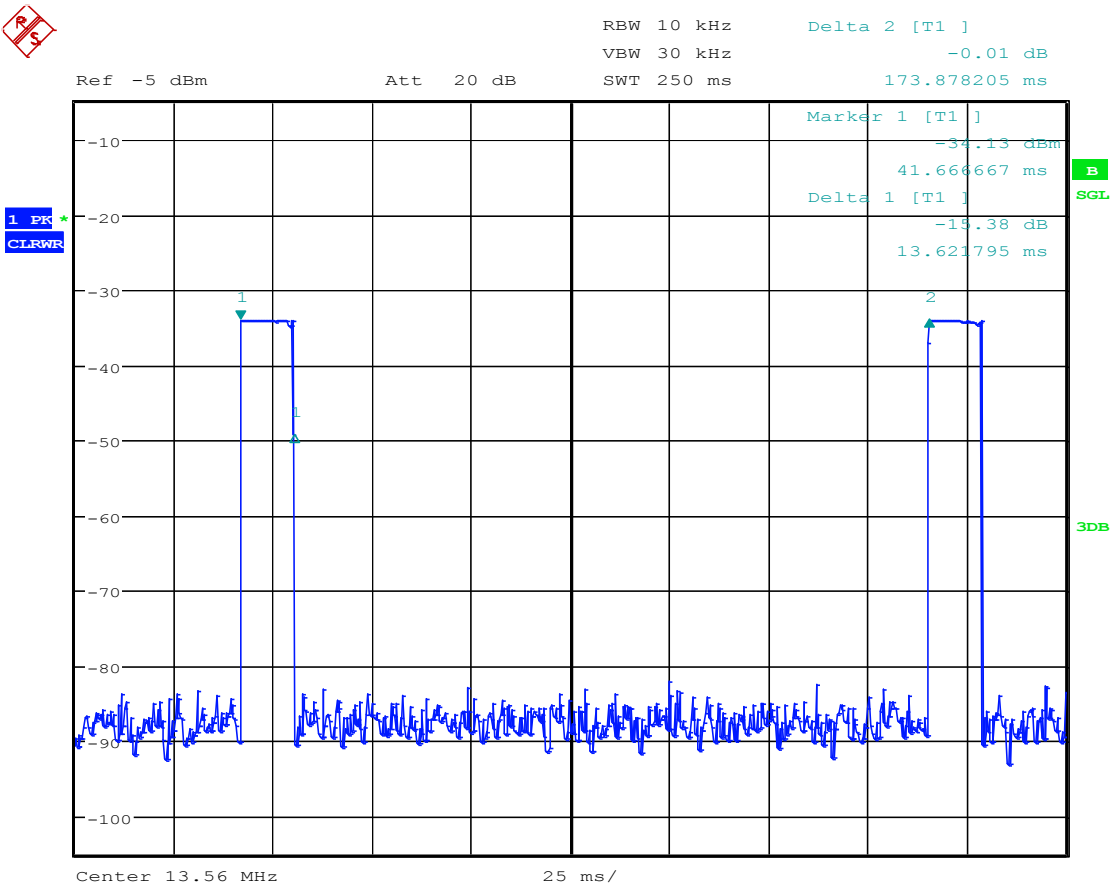
3.3 Identification of Ancillary equipment

AE #	Type	Manufacturer	Model	Serial Number
1	Laptop	Apple Inc.	A1369	C02HQ2Q1DJWT
2	AC Adapter	Apple Inc.	A1385	D291236010EDHLH6Q

3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1 + AE #1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with a laptop utilizing a command line interface. The EUT transmitted a modulated NFC signal on the specified channel with maximum possible duty cycle (Measured in 3.4.1).
2	EUT#1 + AE #2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with a laptop utilizing a command line interface. The EUT transmitted a modulated NFC signal on a specified channel with maximum possible duty cycle (Measured in 3.4.1).. The EUT was disconnected from a laptop then connected to an AC adapter (AE#2), the NFC radio transmission was verified with a spectrum analyzer during the course of testing.

3.4.1 Continuous transmission with Maximum Duty Cycle



Date: 21.MAR.2016 18:40:21

Measured Duty Cycle: 7.8%

4 Subject of Investigation

The objective of the evaluation documented in this report was to assess if the performance of the EUT meets the relevant requirements specified by :

- 47 CFR 2: Title 47 of the Code of Federal Regulations: Chapter I-Federal Communication Commission: Frequency allocations and radio treaty matters; general rules and regulations.
- 47 CFR 15: Title 47 of the Code of Federal Regulations: Chapter I-Federal Communication Commission: Part 15 – Radio Frequency Devices – Subpart C – Intentional Radiators – Section 15.225: Operation within the band 13.110-14.010 MHz.
- 47 CFR 15: Title 47 of the Code of Federal Regulations: Chapter I-Federal Communication Commission: Part 15 – Radio Frequency Devices – Subpart C – Intentional Radiators – Section 15.209: Radiated emissions limits; general requirements.
- RSS-GEN- Issue 4: General Requirements for Compliance of Radio Apparatus.
- RSS-210- Issue 9: Licence-exempt Radio Apparatus Category 1 Equipment –Annex B.6: Band 13.110-14.010 MHz

4.1 Dates of Testing:

2016-03-21 to 2016-09-26

5 Summary of Measurement Results

Test Specification	Test Case	Temperature and Voltage Conditions	Pass	Fail	NA	NP	Result
FCC §15.225 (a) RSS-210 B.6 (a)	In-band Emissions	Nominal	■	☐	☐	☐	Complies
FCC §15.225 (e) RSS-210 B.6	Frequency Tolerance	Nominal & Extreme	■	☐	☐	☐	Complies
§15.209 §15.225 (d) RSS-Gen 6.13	TX Radiated Spurious Emissions	Nominal	■	☐	☐	☐	Complies
RSS-Gen 6.6	Occupied Bandwidth	Nominal	■	☐	☐	☐	Reference

Note: NA = Not Applicable; NP = Not Performed

6 In-band Field Strength (Fundamental)

6.1 References

FCC: 15.225 (a)
RSS 210: B.6 (a)

6.2 Limits

FCC: The field strength of any emissions within band 13.553 – 13.567 MHz shall not exceed 15,848 microvolts/meter (84 dBuV/m) at 30 meters distance.

RSS 210: The field strength of any emission shall not exceed the following limits:
(a) 15.848 millivolts/m (84 dBμV/m) at 30 meters, within the band 13.553-13.567 MHz.

The 30m limit is converted to 3m, using the 40 dB/decade extrapolation factor formula as specified by FCC part 15.31 (f)(2) for frequencies below 30MHz.

Therefore, 40 dB shall be added to the specified limit (84 dBuV @ 30 m) to convert to actual test limit **124 dBuV** @ 3m.

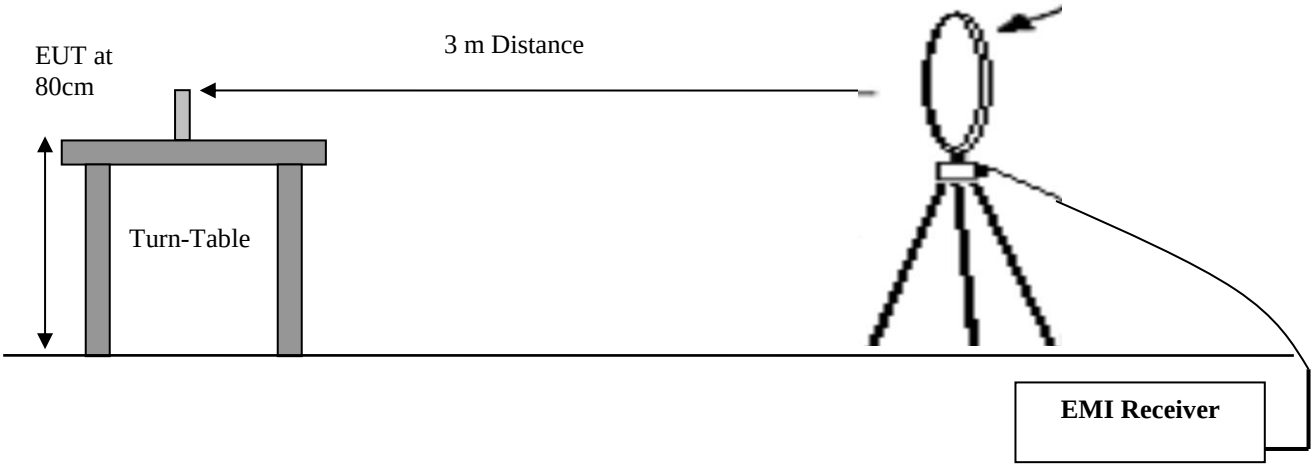
6.3 Test Conditions

Tnom: 21°C
Vnom: 3.7 V dc
EUT Setup #1

6.4 **Radiated Measurement Procedure**

Ref: ANSI C63.10 Section 6.4
Field Strength measurement

Test Setup for Below 30MHz Measurements



1. Connect the equipment as shown in the above diagram with the EUT's antenna in a vertical orientation.
2. Set the EUT in continuous transmission mode with its maximum power and maximum duty cycle.
3. Set the spectrum analyzer to the channel frequency of interest.
4. Maximize the emission amplitude by rotating the turntable 0 - 360°, adjusting the measuring antenna height from 1 – 4 m & changing antenna polarity.
5. Repeat steps 4 with all antennas different polarity and determine the maximized polarity for measurement. Measure and record the peak level of field strength (**LVL**) in dBuV.
6. Adjust correction factors to the measured field strength (**LVL**) and using the field strength approach calculation to convert (**LVL**) from dBuV to transmitter output power (EIRP) in Watts using the following equations:
7. Correction factors (**CF**) in dB = Antenna factor (dB) + Cable loss (dB).
   LVLc (dBuV) = **LVL** (dBdBuV) + **Correction Factors** (dB)

6.5 Measurement Settings

Ref: ANSI C63.10 Section 4.1.4

RBW = 9kHz (see section 6); VBW = 3 x RBW
Span wide enough to capture bandwidth of emission being measured
Detector = Peak; Trace = Max Hold
Sweep time: Auto.

Equipment numbers 1-9 in section 11 of this report were used for this test case in a semi-anechoic chamber.

6.6 Measurement Uncertainty

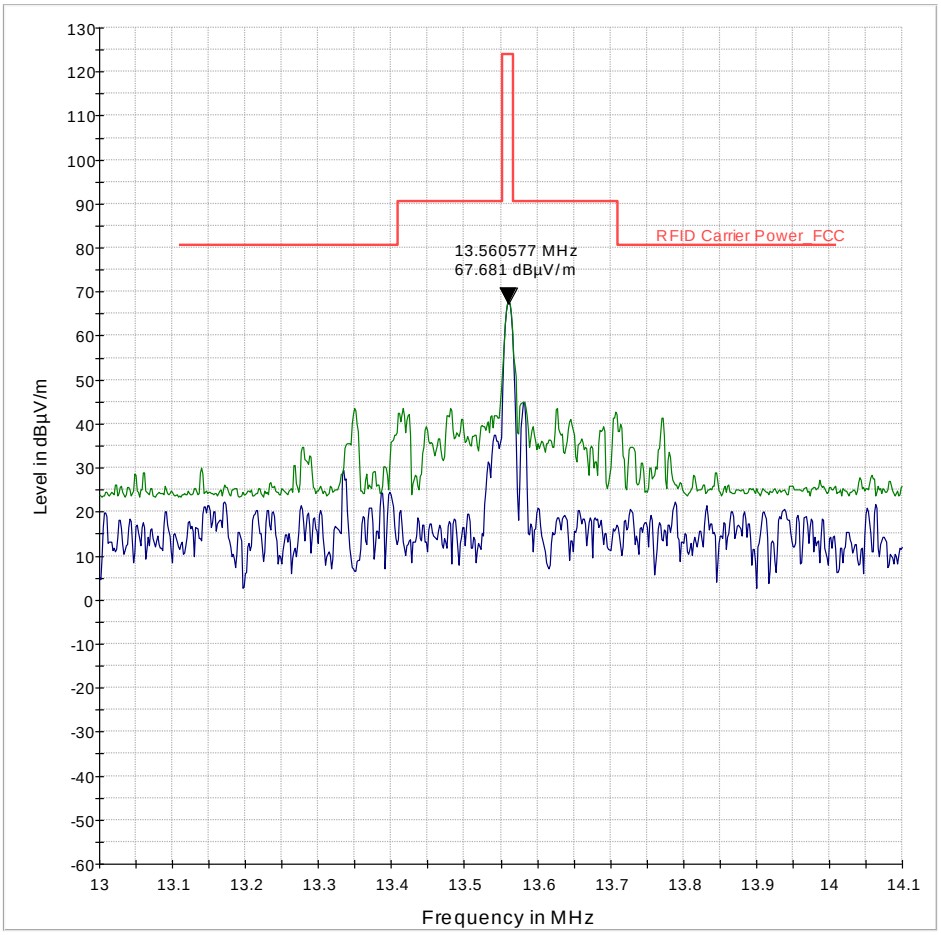
+/- 3 dB

6.7 Measurement Verdict

Pass.

6.8 **Measurement Plots**

Field Strength		
Frequency: 13.56 MHz	**NFC –Type A**	**Modulation: ASK**



7 Transmitter Spurious Emissions – Radiated

7.1 Limits

FCC: 15.225 (d)
FCC: 15.209
RSS-Gen 6.13

FCC 15.209 & RSS-Gen Section 7.2.5

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (m)
0.009–0.490	2400/F(kHz)	300
0.490–1.705	24000/F(kHz)	30
1.705–30.0	30 (29.5 dBµV/m)	30
30–88	100 (40dBµV/m)	3
88–216	150 (43.5 dBµV/m)	3
216–960	200 (46 dBµV/m)	3
Above 960	500 (54 dBµV/m)	3

The 300m and 30m limit is converted to 3m, using the 40 dB/decade extrapolation factor formula as specified by FCC part 15.31 (f)(2) for frequencies below 30MHz.

7.2 Measurement Settings

Ref: ANSI C63.10 Section 4.1.4

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

RBW=9 kHz for measurements below 30 MHz
RBW=100 kHz for measurements from 30 MHz – 1 GHz
RBW=1 MHz for measurements above 1GHz
VBW≥ 3x RBW
Span= Entire range of measuring antenna or in segment
Detector: Quasi-Peak from 30 MHz – 1 GHz
1GHz < Average < 30 MHz

Equipment numbers 1-9 in section 11 of this report were used for this test case in a semi-anechoic chamber.

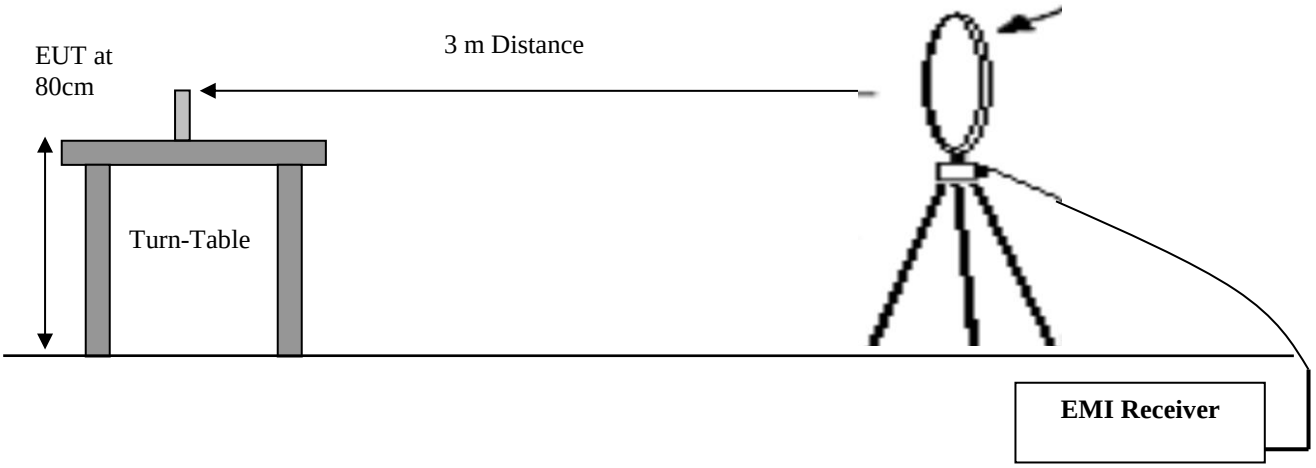
7.3 **Test Conditions**

Tnom: 24°C
Vnom: 3.7 V dc
EUT Setup #1

7.4 **Radiated test procedure for transmitter spurious emissions below 30MHz**

Ref: ANSI C63.10-2013 Section 6.4

Test Setup for Below 30MHz Measurements

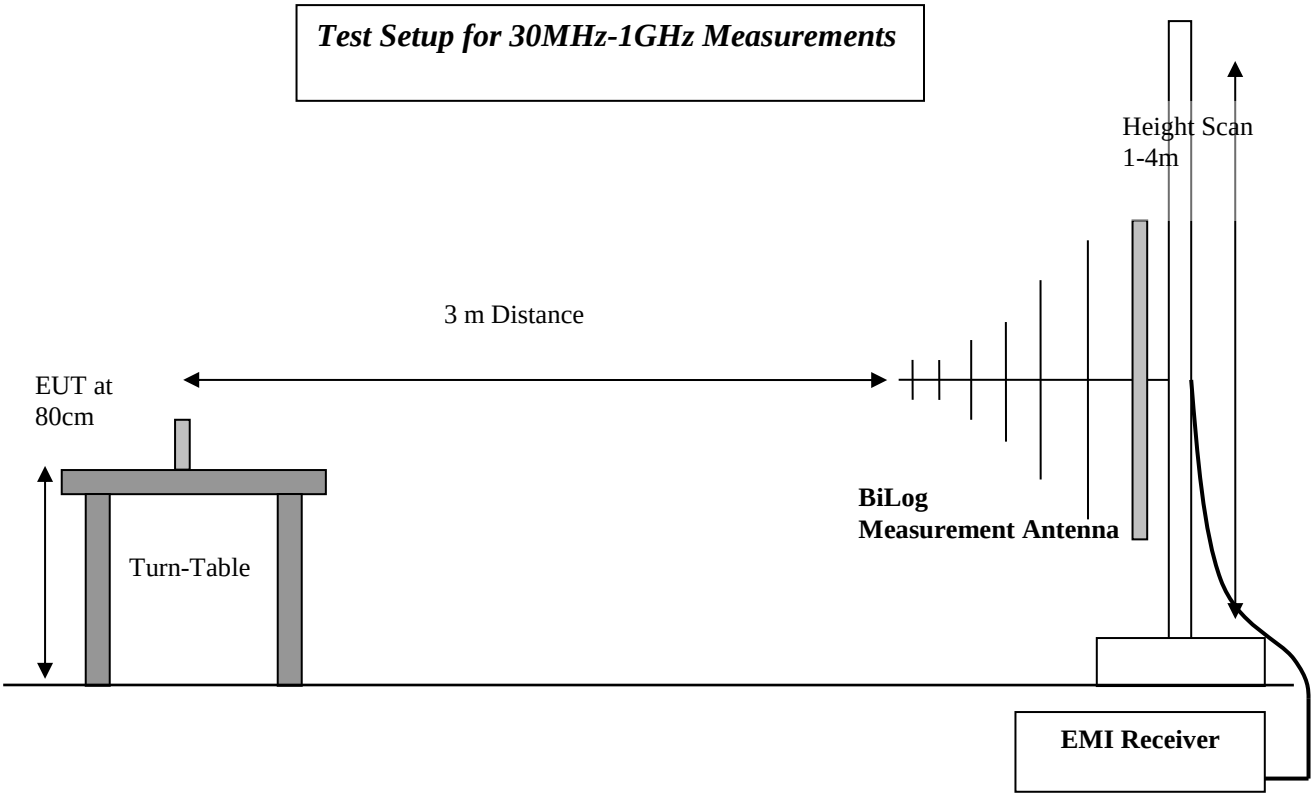


1. Connect the equipment as shown in the above diagram with the EUT's antenna in a vertical orientation.
2. Set the EUT in continuous transmission mode with its maximum power and maximum duty cycle.
3. Set the spectrum analyzer to the channel frequency of interest.
4. Maximize the emission amplitude by rotating the turntable 0 - 360°, adjusting the measuring antenna height from 1 – 4 m & changing antenna polarity.
5. Repeat steps 4 with all antennas different polarity and determine the maximized polarity for measurement. Measure and record the peak level of field strength at 50Ohm of receiver (**LVL**) in dBuV.
6. Adjust correction factors to the measured voltage (**LVL**) to convert (**LVL**) from dBuV to dBuV/m.
7. Correction factors (**CF**) in dB/m = Antenna factor (dB/m) + Cable losses (dB).

LVLc (dBuV/m) = **LVL** (dBuV) + **Correction Factors** (dB/m)

Ref: ANSI C63.10-2013 Section 6.5

Test Setup for 30MHz-1GHz Measurements



7.5 **Measurement Uncertainty**
+/- 3dB

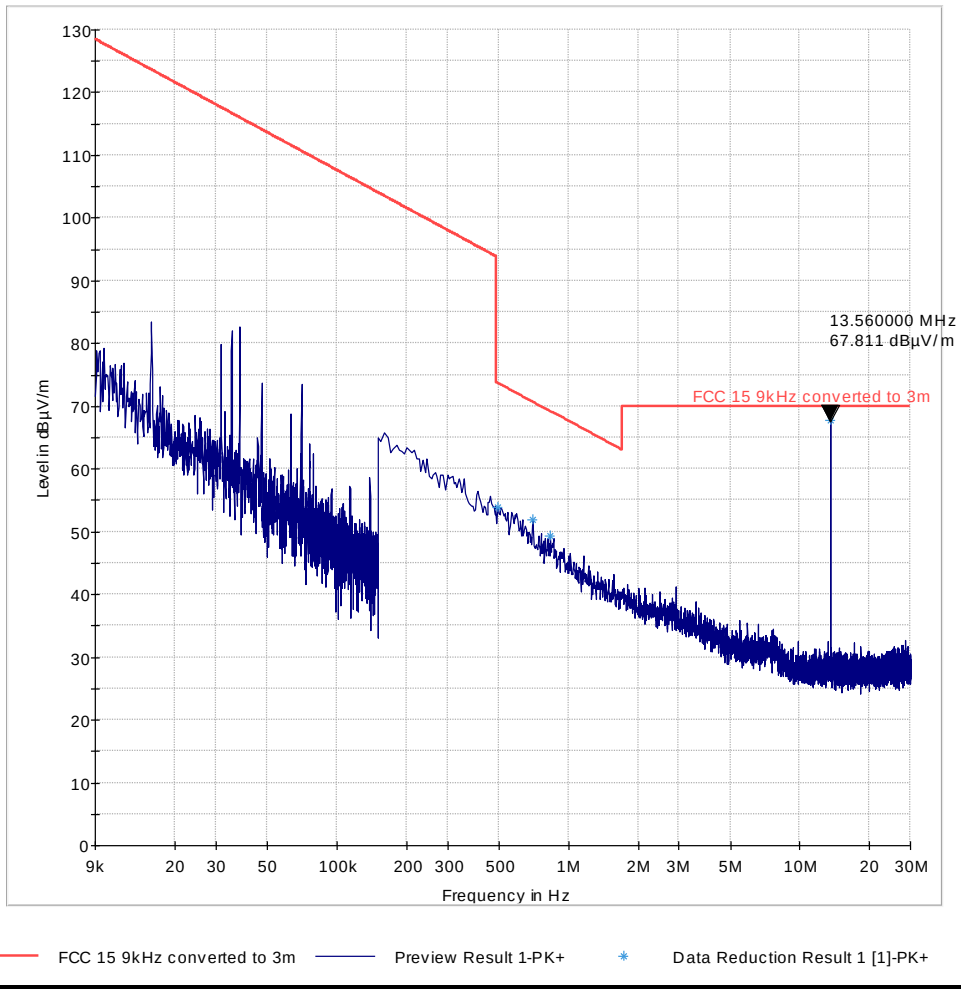
7.6 **Measurement Verdict**
Pass.

7.7 **Measurement Plots:**

Note: The plots below depict worse case measurements of three orthogonal orientations of the EUT.

TX Radiated Spurious Emissions: 9kHz – 30MHz

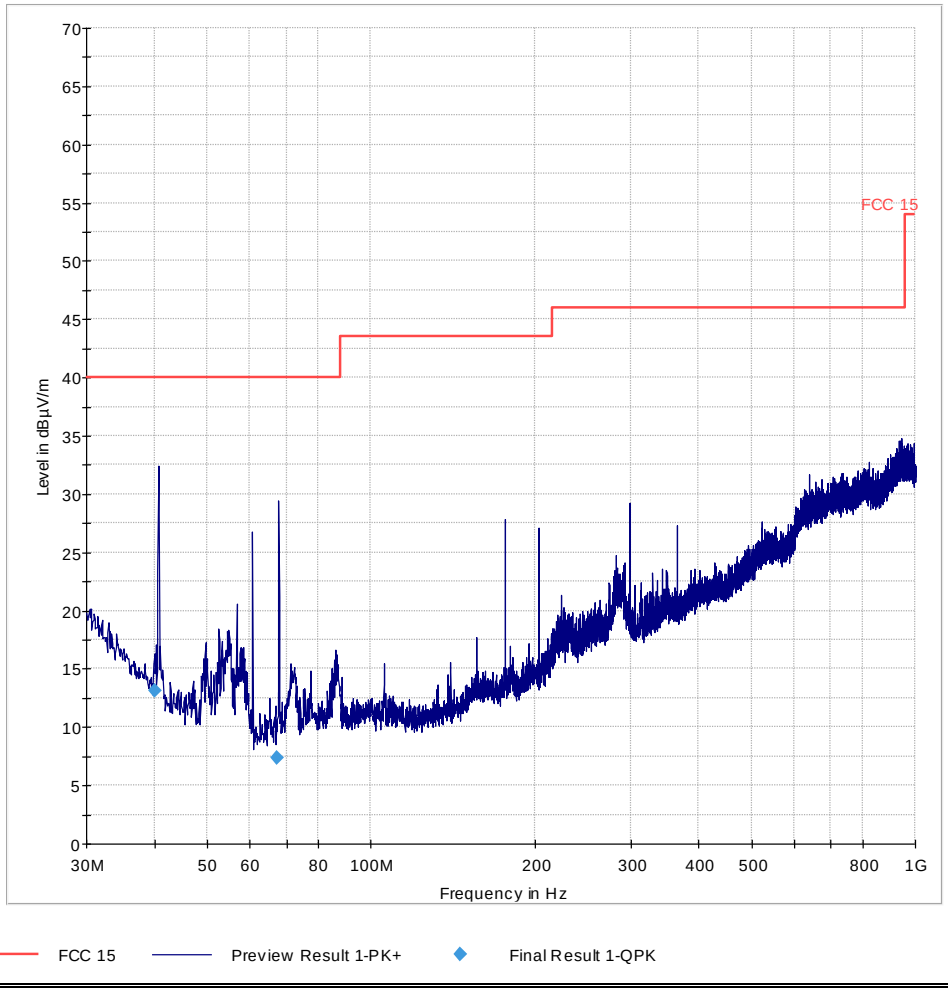
Frequency:15.56 MHz	**NFC TX**	**Modulation: ASK**	



Note: Emission at 13.56 MHz is the Tx Signal

TX Radiated Spurious Emissions: 30MHz – 1 GHz

Frequency:15.56 MHz	NFC TX	Modulation: ASK	



Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
40.010000	13.1	100.0	120.000	140.0	V	270.0	12.1	26.9	40.0
67.340000	7.4	100.0	120.000	389.0	H	-150.0	8.4	32.6	40.0

8 Frequency Tolerance

8.1 References

FCC: 15.225 (e)
RSS-210 B.6

Measurement according to ANSI 63.10 Section 6.8

8.2 Limits

FCC: ± 0.01 %
RSS-210: ± 0.01 %

8.3 Test Conditions

Tnom: 21°C
Vnom: 3.7V DC
EUT Setup #1

Equipment number 11 in section 11 was used for this measurement.

8.4 **Test Data**

Frequency Tolerance vs. Voltage Source		
Voltage Source (VDC)	**Measured Frequency (MHz)**	**Tolerance Deviation (%)**
Vmin = 3.2	13.56018	0.0013
Vnom = 3.7	13.56022	0.0016
Vmax = 5	13.56018	0.0013

Note: Below 3.2 VDC the EUT did not transmit.

Frequency Tolerance vs. Temperature						Maximum Deviation (%)
Voltage Source (VDC)	**Temperature (ºC)**	**Measured Frequency (MHz) over Time**				
		0 mins	**2 mins**	**5 mins**	**10 mins**	
3.7	**50**	13.56018	13.56018	13.56018	13.56018	0.0013
	40	13.56018	13.56018	13.56018	13.56018	0.0013
	30	13.56018	13.56018	13.56018	13.56018	0.0013
	20	13.56018	13.56018	13.56018	13.56018	0.0013
	10	13.56022	13.56022	13.56022	13.56022	0.0016
	0	13.56022	13.56022	13.56022	13.56022	0.0016
	-10	13.56022	13.56022	13.56022	13.56018	0.0016
	-20	N/A	N/A	N/A	N/A	N/A

Note: At -20 ºC the EUT did not transmit.

8.5 **Measurement Verdict**

Pass

9 Occupied Bandwidth

The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth of the 99 %.

9.1 References

RSS-Gen 6.6

9.2 Limits

RSS-Gen section 6.6
When an occupied bandwidth value is not specified in the applicable RSS, the transmitted signal bandwidth to be reported is to be its 99% emission bandwidth, as calculated or measured.

9.3 Measurement Settings

Measurement according to RSS-Gen section 6.6

EUT Setup #1

For 99% occupied Bandwidth, use the occupied bandwidth measurement function with the band set equal to 99% emission bandwidth.

Span = wide enough to capture all products of the modulation process, including the emission skirts.
RBW = 1% to 5 % of the OBW
VBW = 3X RBW
Sweep = auto
Detector function = peak
Trace = max hold

Equipment number 11 in section 11 was used for this measurement.

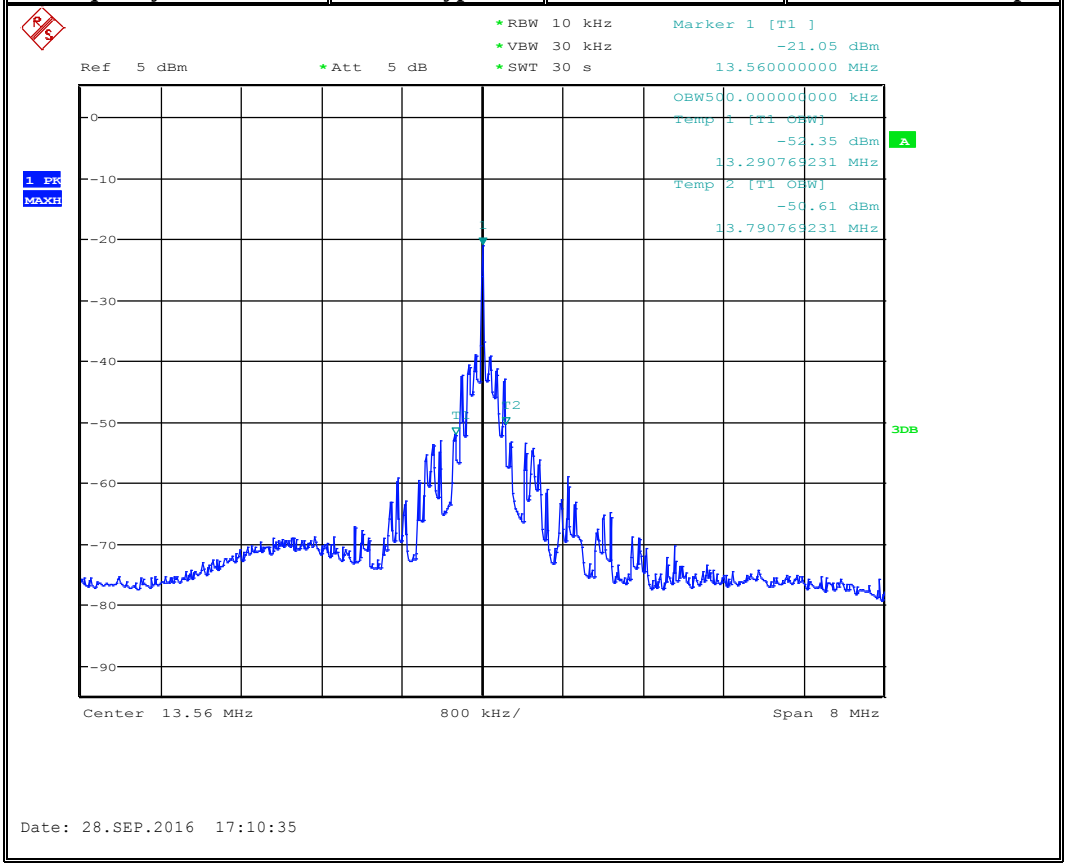
9.4 Test Data

Modulation: ASK **Date Rate: 212 kbps**				
NFC Type	**Frequency (MHz)**	**99% BW (KHz)**	**Limit (KHz)**	**Result**
A	13.56	500	None, as levels are below part 15.209 restricted band limits.	Pass

9.5 **Measurement Plot:**

99% Occupied Bandwidth

Frequency:13.56 MHz	NFC Type A	Modulation: ASK	Data Rate: 212 kbps



10 AC Power Line Conducted Emissions

10.1 Measurement according to ANSI C63.10 (2013)

Analyzer Settings:
RBW = 9 KHz (CISPR Bandwidth)
Detector: Peak / Average for Pre-scan
Quasi-Peak/Average for Final Measurements

10.2 Limits: §15.207 & RSS-Gen 8.8

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

Table 1:

Frequency of emission (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

10.3 Test conditions and setup:

Equipment numbers 6, 11 in section 11 of this report were used for this test case.

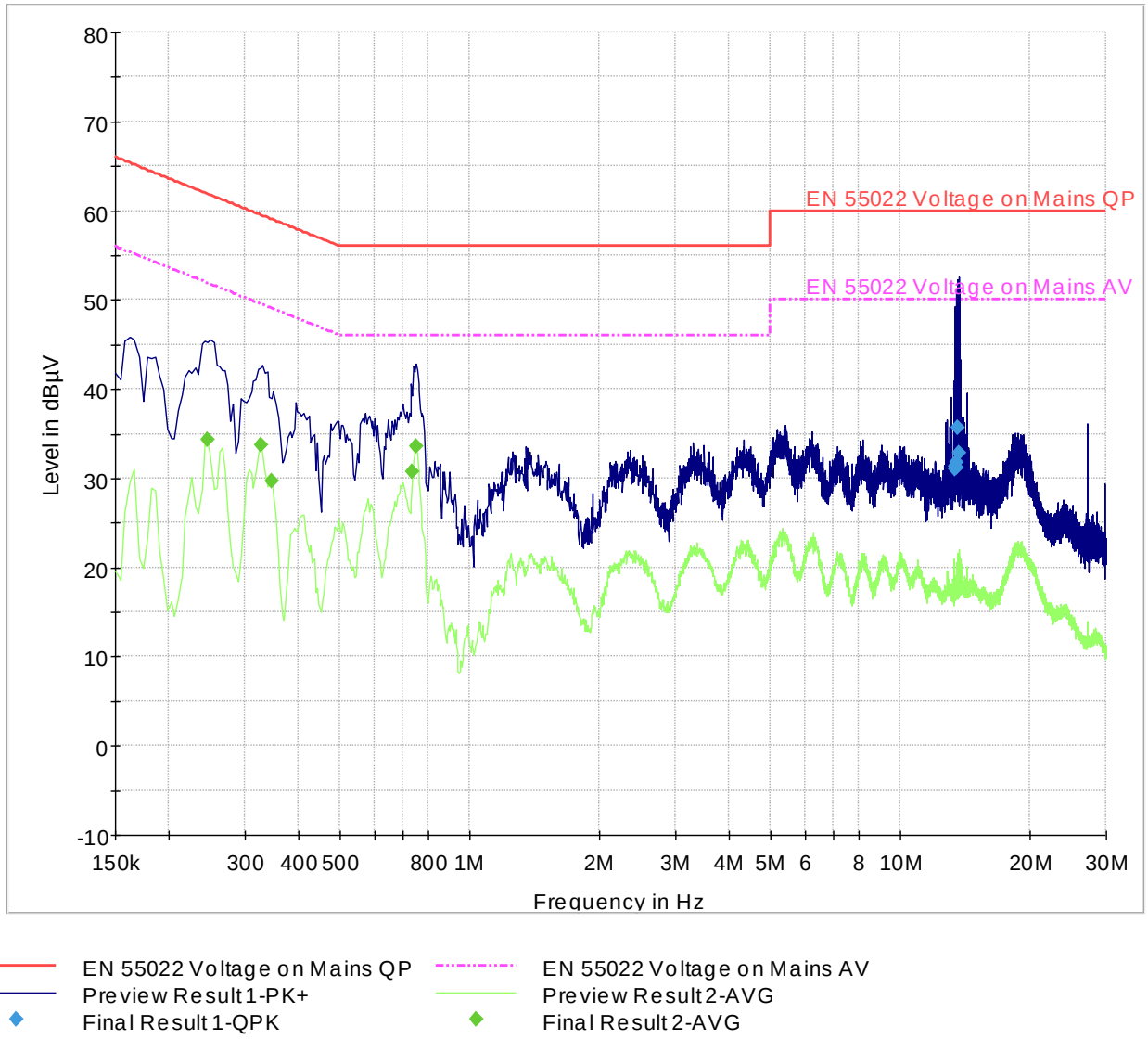
Ambient Temperature (C)	EUT Setup	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22	2	NFC continuous fixed channel	Line & Neutral	110V / 60Hz

10.4 Measurement Result:

Plot #	Port	EUT Set-Up #:	EUT operating mode	Scan Frequency	Limit	Result
1	AC Mains	2	NFC	150 kHz – 30 MHz	See section 11.2	Pass

10.5 **Measurement Plots:**

Plot #1



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
13.350000	31.4	500.0	9.000	GND	L1	0.6	28.6	60.0	
13.418000	31.0	500.0	9.000	GND	N	0.6	29.0	60.0	
13.474000	31.2	500.0	9.000	GND	N	0.6	28.8	60.0	
13.486000	31.8	500.0	9.000	GND	N	0.6	28.2	60.0	
13.586000	35.7	500.0	9.000	GND	N	0.6	24.3	60.0	
13.618000	32.8	500.0	9.000	GND	N	0.6	27.2	60.0	

Final Result 2

Frequency (MHz)	Average (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)	Comment
0.246000	34.4	500.0	9.000	GND	L1	5.6	17.5	51.9	
0.326000	33.7	500.0	9.000	GND	L1	3.7	15.8	49.6	
0.346000	29.7	500.0	9.000	GND	L1	3.5	19.3	49.1	
0.734000	30.8	500.0	9.000	GND	L1	1.3	15.2	46.0	
0.750000	33.6	500.0	9.000	GND	L1	1.3	12.4	46.0	

11 Test Equipment

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
1	Turn table	EMCO	2075	N/A	N/A	N/A
2	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
3	Antenna Mast	EMCO	2075	N/A	N/A	N/A
4	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
5	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
6	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	June 2015	3 Years
7	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
8	Binconilog Antenna	ETS	3142E	166067	Jun 2014	3 years
9	Loop Antenna	EMCO	6512	00049838	Mar 2014	3 years
10	LISN	FCC	FCC-LISN-50-25-2-08	08014	Mar 2015	2 Years
11	Spectrum Analyzer	Rohde&Schwarz	FSU-8	200256	Jul 2015	2 Years

Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.
Calibration due dates, unless defined specifically, falls on the last day of the month.
Items indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.

12 Revision History

Date	Report Name	Changes to report	Report prepared by
2016-10-06	EMC_SQUAR-023-16001_15.225_NFC	First version	Douglas Antioco
2016-12-08	EMC_SQUAR-023-16001_15.225_NFC_rev1	Replaces previous version. Updated: • Added note in Section 7.2 • Added note in Section 8.4 • Equipment #10 in Section 9	Douglas Antioco
2017-01-03	EMC_SQUAR-023-16001_15.225_NFC_rev2	Replaces previous version. Updated: • Updating the manufacturer name in section 2.3 • Updated Section 3.4 wording • Added Duty Cycle Measurement in Section 3.4.1	Douglas Antioco